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Editorial

A Path Forward for Reproducibility

Good science, performed using best practices, may reveal to us fundamental biological truths. Our common goal as health science researchers and practitioners is to make accurate insights into how biological pathways truly work and apply them toward keeping ourselves healthy. When badly conducted science obfuscates or distorts these truths, biomedical progress may stall. Resources and time may be wasted on chasing after the wrong therapeutic target. Or worse—health practices could be misinformed, and patients may become sicker instead of healthier.

Yet, despite these obvious incentives to follow best scientific practices, many feel the system is broken—that scientists are not sufficiently incentivized for rigor and reproducibility, but instead are rewarded for speed, productivity, and for publishing in prestigious journals with high impact factors. These pressures may ultimately discourage careful and rigorous scientific practice, and it is upsetting to observe the ever-increasing number of retractions being published by high impact journals. There is a sentiment, in fact, that biomedical research is in the midst of an identity crisis of sorts—with a number of well-publicized reports over the past few years claiming that a substantial percentage of published scientific studies, spanning several scientific disciplines, are irreproducible. It is daunting to imagine the extent of the problem.

Publication of these reports has understandably met with public alarm as well as deep concern among the research community that something must be done. It is perhaps also not surprising that the chief medical officer of one of the largest pharmaceutical companies in the world has just announced in the April 27th issue of *Science Translational Medicine* a proposal that academic institutions start ensuring reproducibility of their data—with a money-back guarantee on collaborative funding when preclinical data turn out to be wrong. From a strict business standpoint, this disincentive for providing "bad product" probably makes sense. It seems practically challenging, however, for academic laboratories to fully ensure that their results are reproducible within multiple biological contexts and environments—or even to subcontract companies to do this for them. "Financially-insured" biological data are unlikely to be hitting the translational science market any time soon, yet financial pressure may be worth debating as one creative approach toward incentivizing reproducibility.

Another recent approach from funding bodies such as the NIH, is to require applicants to clearly outline within their grant proposals the specific steps being taken toward reproducibility. Beginning with these first grant cycles of 2016, applicants must include detailed description of how they plan to authenticate biological and chemical resources, as well as how they plan to account for biological variables such as the sex and age of model animals. These are all steps in the right direction to help researchers be more cognizant of what measures they should be taking in their own laboratories to ensure the reproducibility of their work.

Standardization of reporting is another best practice being widely adapted by researchers and scientific journals alike. At *EBioMedicine*, we acknowledge our role as editors in promoting reproducibility. We fully embrace efforts by journals and policy makers aimed at ensuring scientific rigor such as the NIH Principles and Guidelines for Reporting Preclinical Research (https://www.nih.gov/research-training/rigor-reproducibility/principles-guidelines-reporting-preclinical-research).

All papers accepted at *EBioMedicine* are subjected to a detailed authors' checklist aimed at ensuring reproducibility, transparency, and accessibility of the paper's data. Just as an example, we ask that all animal studies follow ARRIVE guidelines, and that clinical trials follow CONSORT guidelines. These checklists are now standard practice for many journals, and are designed to facilitate reproducibility by providing as much detailed information as possible about the experimental design and logic, as well as any biological variables that may confound the results. Although we agree that every detail might not always seem immediately relevant at face value—in addition to obviously pertinent information such as statistical details, we encourage our authors to provide sufficient information to replicate each experiment successfully.

Non-profit organizations such as the Global Biological Standards Institute have also been recently established in an attempt to assure reproducibility. The mission of GBSI is in part to create a movement and awareness toward standardizing and authenticating biological reagents such as cell lines and antibodies, and to educate researchers on how to ensure best practices regarding biological standards.

The publication of negative results is also an important consideration in the context of reproducibility. When landmark studies, in particular, cannot be replicated, it is essential that this information becomes part of the scientific discourse. Although negative results may not always be considered as impactful and exciting as positive ones, setting the record straight is essential for moving the field away from dead-end hypotheses and irrelevant therapeutic targets.

Although the issue of irreproducibility in science may be unsettling, at *EBioMedicine*, we join the ranks of scientists and publishers who are taking a proactive, positive view toward changing the landscape to foster better scientific practice.

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